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ABSTRACT

Past media research has tried to show that the medium itself made a difference in instruction and learning outcomes. However there are media attributes that must be considered in instructional design in conjunction with an analysis of the instructional goal. For example, the task requirements, type and level of learner-medium interaction, type and level of media adaptation required, and characteristics of the medium are all factors affecting the design of instruction. Research on the locus of control in learning may also be useful, particularly as it affects student achievement. Although prior studies yield mixed results on increases in student achievement based on locus of control, research has identified student aptitude, degree of inquiry, and prior knowledge as individual differences that affect the use of learner control. Interactive video combines computer assisted instruction with characteristics of video to provide an integrated educational environment that can be manipulated by the learner. However, the potential of this medium will only be realized through the design of quality instructional programs and effective implementation. (22 references) (DB)

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by

Karen Lee Jost, 1990

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Computer-Based Interactive Video: The Potential for Effective Instructional Environments

Karen Lee Jost

Introduction: Past Media Research

Past media research tried to show that the medium itself made a difference. To do this, comparisons were made between media, often comparing a new medium with traditional instruction where the two forms of instruction were made as similar (as equal) as possible. The only difference was in the medium delivering the instruction. Research studies employing experimental and quasi-experimental designs to compare instructional technologies have produced few useful outcomes (Reeves, 1986; Clark, 1983; Hoban, 1958).

Media comparison studies most often result in "no significant difference" conclusions. When such studies do show differences in learning between treatments, where the treatments use different media to deliver instruction, Clark (1987) argues that the differences are due to confounding and are not attributable to any one medium over another. He also identifies the most common sources of confounding in media research to be the uncontrolled effects of instructional method or content differences between treatments and the novelty effect of newer media, which tends to disappear in time (Clark, 1983).

Another problem with research using comparisons between media is that it assumes a prototypical or uniform medium. It does not consider within-medium differences as relevant. A further problem with much of the media research of the past is that it assumed uniform effects for all learners. Both Aptitude-Treatment-Interaction findings and observations of differences in how learners approach and perform activities render this assumption unwarranted.

Clark further disputes the theory that different media contribute to learning by providing attributes that cultivate cognitive skills . He notes that whenever an attribute seemingly specific to a medium is found that does cultivate a cognitive skill, it is not necessary for the acquisition of the

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skill because other attributes or presentation forms exist that will teach the same cognitive skill (Clark, 1987).

Salomon (1979) demonstrated that the symbolic modes employed by media can affect the mastery of mental skills, and how differences among symbol systems affect the acquisition of knowledge and affect cognition. He identified four aspects of media that may potentially affect learning: the technology they use, the symbol systems they employ, the content they convey, and the setting in which they are encountered. Winn (1987) added a fifth aspect: the thoroughness that goes into the design of the messages that they convey. But Winn then goes on to explain that symbol systems, contents and setting are simply correlates of a medium's technologies. They represent the general case of how a medium is used. They are not attributes that are inherently present in a medium and they may not be unique to any one medium.

In terms of research in instructional technology, the above distinction is very important. Research needs to be directed not at the medium, but at such things as instructional methods, the settings in which instruction takes place, the cognitive processes engaged through the use of symbol systems, the effect of how content is structured, and the use of learning strategies. It is also important to explain how individual differences affect how learners process or carry out instructional activities and to investigate the impact that various kinds of interactions can have on different learners. Refined questions focusing on specific salient attributes and qualities of a medium, such as the depiction of movement, also furnish us with important information which can be applied to the design of effective instruction. Research on symbolic elements of media must be done with caution. Elements producing an effect may be sufficient but not necessary to produce a cognitive effect (cf. Clark & Sugrue, 1989). The development of instructional theory is dependent on identifiying necessary conditions for learning.

Salomon has demonstrated that the way a learner perceives the source of information, i.e. the medium, influences the amount of mental effort expended in the learning process, and therefore, may affect learning (Salomon, 1983). He has also shown the importance of studying the context and environment within which instruction takes place (Salomon & Gardner, 1986).

Relevant to research on instruction delivered by computers, as learning activities become more interactive and less structured, giving more control to the student, the range of experiences that students can encounter increases as does the range of possible outcomes from the instruction (Salomon & Gardner, 1986; Linn, 1985). The diversity of possible outcomes presents difficulties for research which assumes the attainment of common goals.

Given all of the above problems that media research, including research on interactive video, has had in the past, why is there still interest in interactive video? What can it accomplish that other media can't already accomplish? Are there any real benefits from its use?

Analyzing the Task Before Choosing the Medium

Before proceeding with a discussion of the capabilities of computer-based interactive video as an instructional medium, it is important to begin with a method for analyzing an instructional goal which will facilitate the selection of an appropriate delivery medium. The effective design of instruction begins with an analysis of the instructional objectives, learner characteristics, and the environment in which instruction is to take place. Jonassen (1985) presents a taxonomy for interactive, adaptive lesson design which is helpful in analyzing the instructional requirements necessary for guiding the selection of an appropriate medium. He suggests that you consider the instructional requirements in terms of:

- task / content requirements of the objectives
- type / level of learner-medium interaction
- type / level of adaptation by the medium that is required
- the characteristics of the medium needed to provide that adaptation.

Task/Content

Task requirements may vary as a function of the content or as a function of the objectives for the program. Learners should receive the treatment that best models the processing requirements of the task. The sequence of the presentation may also be altered to accommodate

differences in task or content requirements. For example, the discovery or inductive approach (EGRULE) is recommended if the goal of instruction is for learners to be able to transfer rules to novel situations.

If learners are aware of the structure of knowledge being studied, their comprehension of the content improves. The structure or organization of the content that is being presented can be signaled explicitly to make it easier to comprehend. The structure of the content may also be reflected in the structure and sequence of the presentation. Structuring content at this level attempts to represent things the way they are. The different classes of content structure have been conceptualized to include world-related, concept-related, and inquiry-related perspectives (Posner and Strike, 1976).

Learner-Medium Interaction

The interactive dimension of interactive technologies describes the way in which learners respond to an instructional program. The more *mentally active* learners are as they process information from instructional materials, the more likely they are to generate meaning (Jonassen, 1985). The nature of learner-medium interactions can be viewed in terms of the task, the level of processing required to complete the task, and the context in which the instructional program will be used.

Task analysis needs to consider both the nature of the learning task and the content level of the material being processed. Learning tasks represent either "remember" or "use" learning behaviors. A "remember" task entails only recall; at the "use" level learners apply knowledge. Content level refers to the type of information being processed, which determines the type of knowledge constructions necessary for acquisition. There are a number of taxonomies which classify content. Merrill's Component Display Theory distinguishes between facts, concepts, procedures, rules and principles. Landa (1983) makes a clear distinction between knowledge and skills, emphasizing their interconnectedness (cf. Dijkstra, 1990). It is important to make both instruction and evaluation procedures consistent with the nature of the task to be learned.

Learning is a constructive process. Interactive instructional designs should encourage the learner to construct more elaborate mental representations, rather than reflexively responding to information on a screen. In designing interactive lessons, the learner needs to be encouraged to access prior learning and relate the new material more consistently to it.

Adaptation by the Medium

Adaptive designs enable the delivery of alternative instructional sequences based upon a variety of learner, content, or situational characteristics. Lesson strategy or content can adapt to the learner (external) or to the information (internal). External adaptation can occur through:

- branching on performance
- diagnosing prior learning
- accommodating to learner characteristics
- learner control of instruction
- knowledge-based systems
- curricular adaptations.

Instructional programs can internally adapt in terms of task requirements, content sequencing, content structure, and curriculum development.

Characteristics of the Medium

Computer-based interactive video is a complex combination of technologies. In order to fully understand its attributes, capabilities, and potentials we need to look at its many component parts. From an educational standpoint, we are not only interested in how they have been typically used, but in what they can potentially be made to do.

The aspects of media identified by Salomon and Winn (Salomon, 1979; Winn, 1987) as potentially affecting learning are important factors to consider when designing instruction and choosing a medium to use. A thorough analysis of the critical features of a medium or technology,

its most essential characteristics, and the activities afforded by the medium, are also important considerations in choosing a delivery vehicle for instruction.

The most important capabilities afforded by computers as part of an instructional system include: the ability to engage the learner (requires interaction); levels of control (adaptability); and management capabilities (e.g. data storage and manipulation). CBIV is an interactive technology. Interaction need not be thought of as requiring an observable response. The activity should keep the learner mentally active through the use of authentic activities. The instruction needs to support learners in the construction of knowledge. Activities which require the learner to access prior knowledge, to classify, compare or contrast, to discover relationships or a structure to the content itself, support the level of interaction needed for the learner to acquire a meaningful understanding. Instruction can be designed which explicitly supplants mental operations accomplishing specific cognitive functions that some learners do not possess the skills to accomplish on their own. Supplantation can be used both to facilitate knowledge acquisition and to cultivate mastery of the mental skill involved. It has been suggested that the amount of compensation be manipulated, beginning with full support which is gradually withdrawn.

The effectiveness of an interactive design is dependent not only on the interaction itself, but on the way that the instruction responds or *adapts* as a result of the interaction. Instructional designs can adapt to the learner or to the information by adaptation of the lesson strategy or content (see Adaptation By the Medium above). Adaptation can also occur through learner control of the instruction. CBIV can provide learners with control over the range and depth of content, including the level of difficulty. It can also provide learners with strategy options, choice of examples (e.g. context, number), and choice of amount of practice. Learners may also be given control of the density of presentation, modality options, and navigational control, including the ability to exit and reenter the program. Learners are often given control over the pace of presentation, particularly where text is concerned.

While the idea of giving students control of their own learning has a strong intuitive appeal, research has shown that learners do not always choose what is best for them. Low-ability students

often rush through instruction, while high-ability learners explore every possible branch of the instruction.

Research on Learner Control

Research on learner control of instruction indicates mixed results in terms of student achievement. Kinzie (1990) discusses possible explanations for the inconsistent results from research on learner control. The use of a behaviorist rather than a cognitivist orientation is presented as a possible source of inconsistent findings in learner control research. A cognitivist design allows for student control over direction and monitoring of the learning process. In a cognitivist design instruction also tends to be at higher difficulty levels and is presented in larger chunks. This type of instruction is more "far transfer" where the relevant outcome is long-range achievement and continuing motivation to learn. Therefore, in research where achievement measures are used which are more typical of a behaviorist design, (i.e. immediate recall, more "near transfer"), the real effects of learner control may not be measured.

The second possible source for inconsistent findings in learner control research, cited by Kinzie, is that of individual student differences. Individual differences play an important role in how learners process information and utilize control of instruction. One cannot assume that control is mindfully experienced (Salomon & Gardner, 1986; Chanowitz & Langer, 1980). Motivation, perception of task, and preferred learning strategy all affect how individuals tend to, or choose to, process information or perform activities presented to them during instruction (Salomon & Gardner, 1986; Salomon & Leigh, 1984). Learner control research has identified student aptitude, degree of inquiry, and prior conceptual understanding as individual differences which affect the use of learner control. Students possessing high aptitude, high inquiry, and prior content knowledge tend to benefit from the use of learner control.

The third source identified by Kinzie is that of discomfort/inexperience in exercising control options. To adequately measure the possible benefits of learner control, whether achievement or attitude, students need to be experienced with using the technology and must know how to

effectively exercise control. Instruction should include information about learner control options and practice in exercising them. Control options also need to be both appealing and non-threatening.

Research on learner control has shown that learners don't always make the right decisions in controlling or managing their own learning. This may often be due to deficient learning strategies, meta-cognitive skills, existing conceptual schemata, or motivation. Adaptive instruction, where computer-based algorithms prescribe the best strategies for individual learners, has produced higher levels of achievement than total learner control. But learner control studies do support long-term retention, positive attitudes, and a strong, intuitive appeal for learner control (Milheim and Azbell, 1988).

Learner control with advisement not only appears to be a good compromise between the benefits of adaptation and the appeal of learner control, but is also supported by research when compared with learner or adaptive control. Advisement can make suggestions on how to exercise control and when to use it. Advice can be given as to the optimal amount of practice which is needed, based on sophisticated models. Advice can also be in the form of information to aid learners in making decisions in managing their own instruction, such as how the student's performance compares to program criteria. Based on performance, students can also be advised to review previously presented content. When advising, a rationale should be provided so that students can make informed selections and may learn to manage their own instruction (Milheim and Azbell, 1988).

One alternative to full learner control is to limit the initial control, which is given to the student, until the student can demonstrate that he/she possesses the basic knowledge schema required to make meaningful decisions as the instruction proceeds. As the learner masters the required basics, control can gradually be turned over to him/her. While students can be allowed to choose what instruction they feel they need, rather than simply allowing them to omit important information, they could be given the option of testing out of the instruction.

The Potential of Interactive Video

If media are only vehicles for instruction and do not directly influence learning, when is it appropriate to use them? Clark views the benefits derived from the use of media in education and training as being primarily economic in terms of saving a significant amount of instructional development, learning and delivery time, and money (Clark, 1987).

Bosco (1984) discussed several issues with regard to the implementation of videodiscs in education. He stated that , "Effective utilization involves an understanding of the points of convergence between capabilities of the interactive video system and the nature of educational tasks." (p. 14). The capabilities that he views as beneficial to the educational use of interactive video include:

- replicability and cost of instruction
- responsiveness to human variability
- active participation
- the use of video information
- assessing and managing instruction
- the video chalkboard
- the video (reference) book
- the video teacher (intelligent tutor).

Some of the above capabilities are due to the computer component, others are due to the video component, while others are only possible through the unique combination of these capabilities.

Interactive video combines characteristics of video with characteristics of computers. When designing interactive video, the strengths of each are utilized. Computers and video complement each other; the strengths of one offset the limitations of the other. The primary strengths of video are its realistic depictions and ability to show motion. It also provides for quality audio. Video is generally limited by an inflexible linear presentation and an inability to engage the learner, who remains a passive observer instead of becoming an active participant. Video does not easily lend itself to the instruction of higher order skills and does not adapt to

individual learner needs. The primary strengths of computers are their flexibility, levels of control, ability to engage the learner, and management capabilities. They are limited by a lack of realism and dramatic power. CBIV gives us the power to create a learning environment that engages the learner, can adapt to learner characteristics, can empower learners to take control of their own instruction and can utililize real images and motion, thus being capable of teaching not only higher order concepts, principles, procedures, and motor skills, but also lending itself to instruction dealing with attitudes. CBIV can also be used as a powerful tool to aid the learner in acquiring learning strategies and meta-cognitive skills.

One additional powerful application for interactive video is in distance education. The Yugtarvik Museum Project in Alaska is a good example of this type of application. This project developed culturally-relevant interactive programs so that students in distance education courses would be less dependent on learning over the telephone and more likely to become self-learners through on-site interactive systems. The dual audio track on the videodisc made it possible to have the program presented in both English and Yup'ik (cf. Sponder and Schall, 1990).

The use of interactive video can provide both on-campus and distance students with a richer, more effective environment for learning. It can provide the additional benefits of magnifying live demonstrations, the ability to replay in slow motion, to show close-ups, to pause and rewind, and to choose time and place, that are not present with live lectures. CBIV can aid students in internalizing complex ideas and skills. It can offer applications in numerous contexts to aid in the transfer of skills to multiple situations. CBIV can provide students with a supportive environment within which they are allowed to think at their own pace, are given the opportunity to rethink assumptions, and have the time to reflect on their own learning (Ehrmann, 1990).

Conclusion

The potentials of computer-based interactive video will only be realized through the design of quality instructional programs and proper and effective implementation. In order to design

quality programs, numerous interacting factors which affect the design need to be considered and thoroughly understood. Among these are the factors depicted in Figure 1.

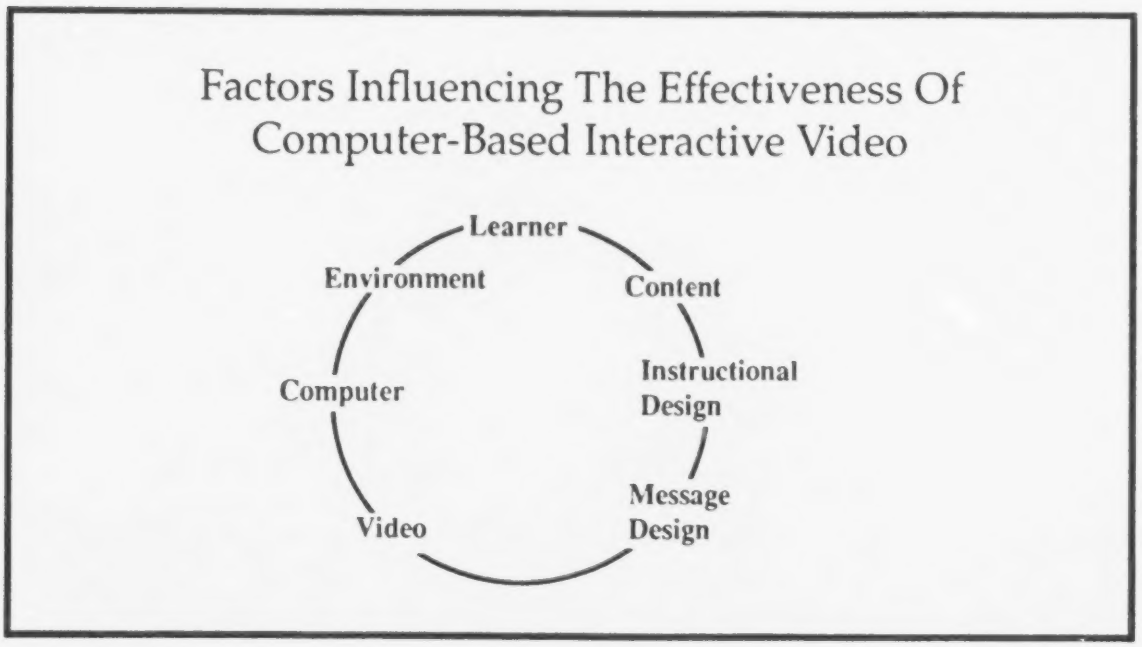

FIGURE 1. From Designing CBIV: Factors to Consider, Hypercard Stack developed by K.L. Jost

When designing CBIV, the interactive and adaptive capabilities should be used to mentally engage learners, providing learners with activities which will aid them in constructing their own understanding rather than presenting information to be absorbed. Effectively designed instruction should help students to develop learning strategies and meta-cognitive skills. We should not use this powerful medium to present information to passive learners from which only the rote recall of information is required. Not only is such a use a waste of resources, but we will be running the risk of learners perceiving the medium as requiring little effort.

Most importantly, the best designs will not be effective if both teachers and students aren't taught how to effectively use both the technology and specific program options. The way that an instructional program is used is crucial.

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